Alaska Fisheries Data Series Number 96-2

Estimates of Angling Effort, Catch, Harvest and Population Structure of Coho Salmon Caught and Harvested by Sport and Subsistence Fisheries at the outlet of Becharof Lake, Becharof National Wildlife Refuge, Alaska 1994 and 1995

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April 1996

United States Department of the Interior
Fish and Wildlife Service
Region 7
Fishery Resources

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ABSTRACT

The Becharof Lake drainage supports fish populations that sustain subsistence and sport fisheries in-river and commercial fisheries in saltwater. The lack of specific in-river harvest data prompted the King Salmon Fishery Resource Office to conduct a creel survey to assess in-river fishery impacts to the coho salmon (*Oncorhynchus kisutch*) population in the Egegik River from the outlet of Becharof Lake to 6 km downstream in 1994 and 1995. In 1994, 205 anglers caught 489 and harvested 325 coho salmon from July 31 and September 11. In 1995, 298 anglers caught 694 and harvested 439 coho salmon from August 3 and September 24. From our aerial surveys and other public use camps, the coho salmon effort is currently focused in the Egegik River and the Alaska Department of Fish and Game's Statewide mail out survey provides a good indication of sport catch and harvest levels in the Egegik River.

INTRODUCTION

The Becharof Lake drainage supports fish populations that sustain subsistence and sport fisheries in-river and commercial fisheries in saltwater. These populations are also a major food source for brown bears (*Ursus arctos*), bald eagles (*Haliaeeteus leucocephalus*), and other predators/scavengers. In recent years, residents of Egegik have expressed concern over apparent declining numbers of coho salmon (*Oncorhynchus kisutch*) and resident species in the Egegik River near the outlet of Becharof Lake (outlet area). These declines are associated with an observed increase in the numbers of fly-in sport fishermen in the Egegik River near Becharof Lake. The Alaska Department of Fish and Game monitors the coho salmon run primarily using harvest data from the commercial fishery. The lack of specific in-river escapement and harvest data prompted the King Salmon Fishery Resource Office to begin a two part project. This report covers

the creel survey aspect of assessing in river fishery impacts to the coho salmon population near the outlet of Becharof Lake, Becharof National Wildlife Refuge (Refuge). The second part was to estimate coho salmon escapement and the results are presented in a separate report (Russell 1996).

The Egegik River begins at the outlet of Becharof Lake, the second largest lake in Alaska, and flows approximately 50 km to Bristol Bay (U. S. Fish and Wildlife Service 1985) (Figure 1). The outlet area extends from the rapids at the mouth of the lake downstream approximately 6 km. This area is used by both subsistence and sport anglers. Fishermen access the area using float planes, wheel planes and boats. Most of the anglers are guided and arrive by float plane. Subsistence fishermen use sport gear and target primarily coho salmon but also catch Arctic grayling (*Thymallus arcticus*), Dolly Varden (*Salvelinus malma*), round whitefish (*Prosopium cylindraceum*), and several species of Pacific salmon (*Oncorhynchus* sp.). Sport fishermen primarily target coho salmon with incidental catches of the other species.

Little harvest information is available concerning fish populations upriver from the commercial district. The Alaska Department of Fish and Game's Statewide Harvest Survey (Mills Report) estimates sport effort, catch, and harvest for the entire Becharof/Egegik system using postal surveys. All tributaries of the system are included in this report, and it is not possible to identify data collected from specific areas.

Some information on sport fishing effort and harvest at the outlet area is obtained from reporting requirements for recipients of Special Use Permits (SUP). The SUP report was implemented in 1992 and is filed by sport fishing guides that operate within the Refuge boundaries. This report only gives information on guided use; unguided fishermen (drop-off fishermen, fishermen with their own aircraft, and local boat fishermen) are not included. The reports from 1992-1994 indicated the number of angler days ranged from 103-287. The 1995 reports are not available at this time.

The Alaska Department of Fish and Game monitors the coho salmon harvest by commercial and subsistence fisheries in the Egegik district. From 1974-1994 commercial harvest of coho salmon in the Egegik district averaged approximately 31,000 fish (Alaska Department of Fish and Game 1995). Records for subsistence harvests indicate an average of 365 coho salmon taken annually from 1974-1994 in the Egegik district (Alaska Department of Fish and Game 1995).

The lack of specific effort, catch, and harvest data for the Egegik River prompted the King Salmon Fishery Resource Office to begin a creel survey. The specific objectives were 1) to estimate effort, catch, and harvest of coho salmon by sport and subsistence fisheries within the outlet area; and 2) to describe age, length, and sex compositions of coho salmon caught at the outlet area.

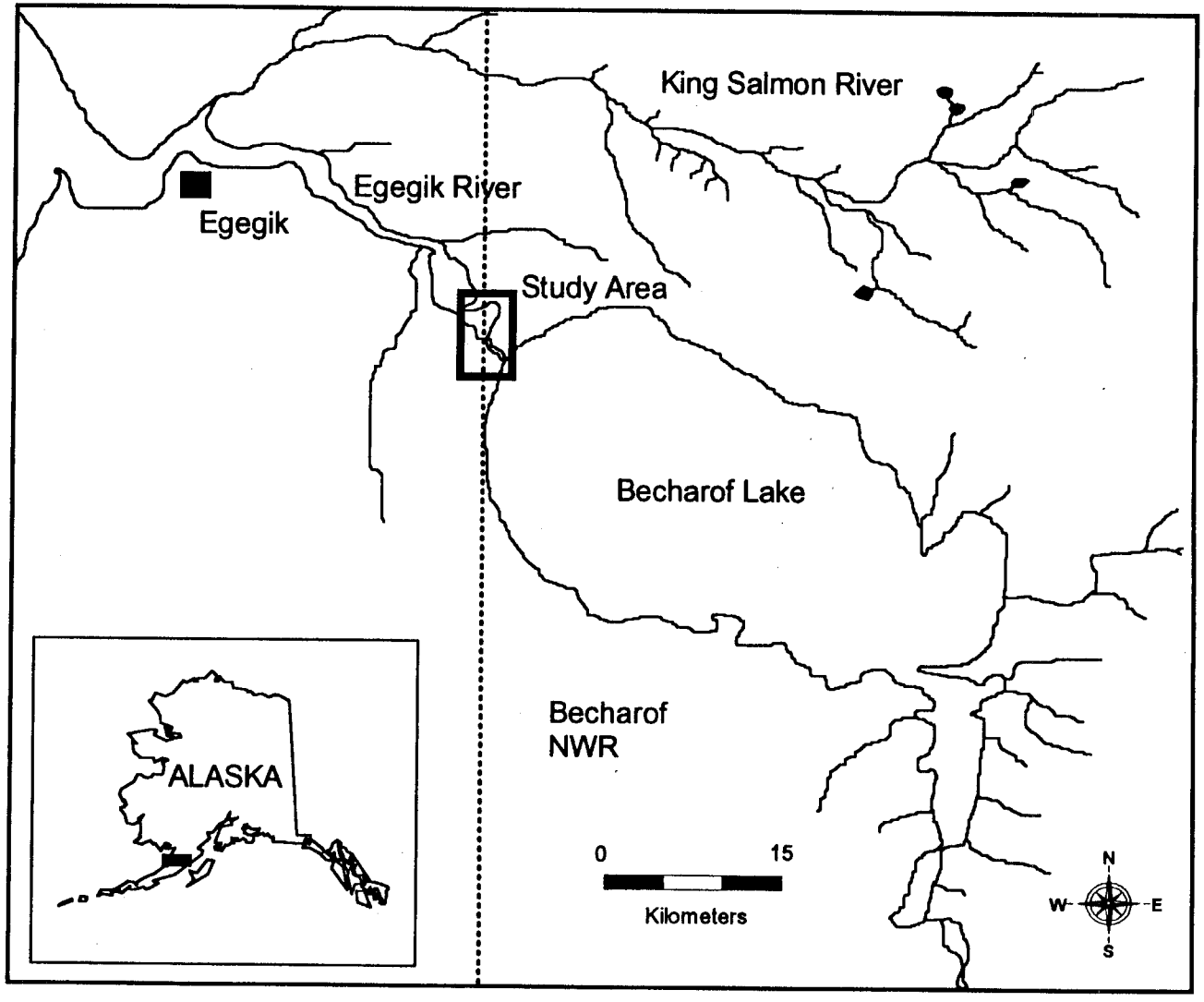

Figure 1.-Egegik River drainage and study area, Becharof National Wildlife Refuge, Alaska, 1994 and 1995.

METHODS

The study area was defined as the Egegik River between the outlet of Becharof Lake downstream approximately six km (Figure 2). Because angling occurred at several sites within this area, this survey was modeled after a roving creel survey (Malvestuto 1983). A two person crew conducted the survey using an outboard motor boat. One crew member would usually stay with a group of anglers throughout the day to sample the harvested and released fish. The other crew member would rove the sample area conducting the angler counts, catch interviews, and catch sampling.

In 1994, all fishermen were interviewed and the data were assumed to be a complete survey. Each angler was interviewed at the completion of each day and data included hours fished, catch, and harvest.

In 1995, the survey method was modified so we could measure potential errors. To determine the daily total effort, measured in angler days, angler counts were conducted throughout the study area at 1100, 1400 and 1700 hours. An angler day was defined as any effort expended by an angler during the calendar day. A typical angler day ranged from 3 to 6 hours. By making the three counts, we assumed all anglers were identified and that the number of angler days were a complete survey.

To obtain catch and harvest information, we attempted to interview all anglers at the end of their fishing day. Only complete-trip interviews were used to estimate catch per angler day. Individual anglers were requested to provide the number of fish caught and harvested by species and to state whether they considered themselves to be sport or subsistence anglers. The following equations from Scheaffer et al. (1986) were used to estimate the total catch and harvest for the season.

The average weekly catch per angler was determined by:

$$\overline{Y_j} = \frac{\sum_{i=1}^{n_j} Y_{ij}}{n_j}$$

Where:

Y_{ij} = catch for the i^{th} angler from complete-trip interviews during the j^{th} week.
n_j = # anglers from completed trip interviews for the j^{th} week.

The total estimated catch for a week was determined by:

$$C_j = N_j \overline{Y_j}$$

Where:

N_j = the sum of the daily angler counts for the j^{th} week.

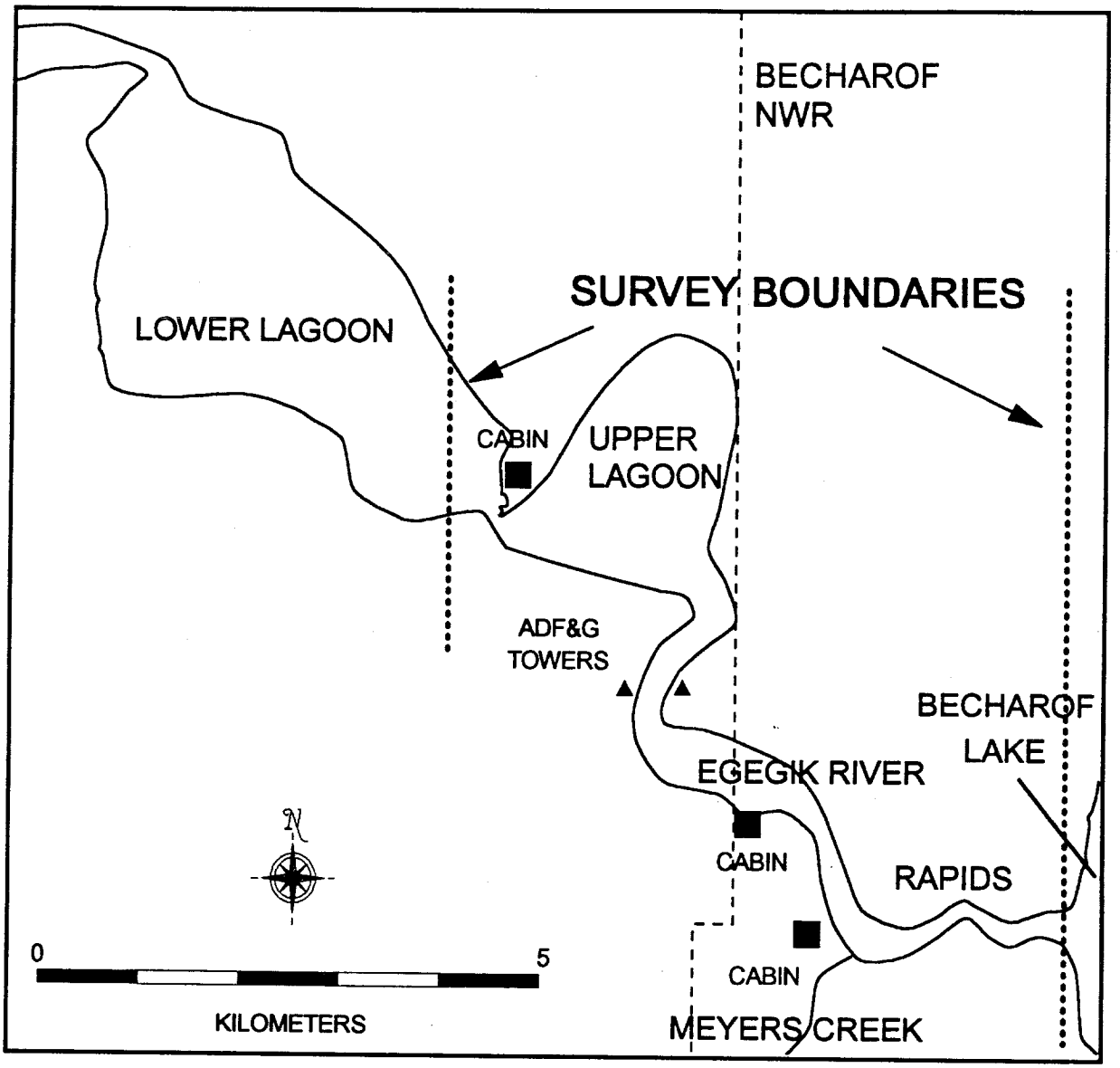

Figure 2.-Location of creel survey area on the Egegik River, Becharof National Wildlife Refuge, Alaska during 1994 and 1995.

The variance of the weekly catch from complete-trip interviews was calculated as:

$$s_j^2 = \frac{\sum_{i=1}^{n_j} (Y_{ij} - \overline{Y_j})^2}{n_j - 1}$$

The variance of the estimated weekly catch was calculated as:

$$VAR_j = N_j^2 \left(\frac{s_j^2}{n_j}\right) \left(\frac{N_j - n_j}{N_j}\right)$$

The 95% confidence interval of the estimated weekly catch was calculated as:

$$CI_j = 2\sqrt{VAR_j}$$

The estimated total catch for the season was calculated as:

$$C_s = \sum_{j=1}^{9} C_j$$

The variance of the season's estimated catch was calculated as:

$$VAR_s = \sum_{j=1}^{9} VAR_{jc}$$

The 95% confidence interval of the season's estimated catch was calculated as:

$$CI_s = 2\sqrt{VAR_s}$$

Scale samples, mid-eye to fork length (mm), and sex determination of coho salmon were obtained from subsamples of the catch and harvest. Scales were taken from the preferred area for age determination (Jearld 1983). The four best scales were mounted from each fish and read by two readers. Unreadable scales were discarded. Discrepancies in the age determinations of the two readers were resolved in conference. Age was reported using the European method (Jearld 1983). Sex was determined using secondary characteristics.

The cumulative length distributions of caught and harvested coho salmon in 1995 were compared using a Kolmogorov-Smirnov (K-S) test. Mean length for males and females was compared using a t-test. The ratio of males and females in the coho salmon catch and harvest in 1995 were tested using a χ^2 test.

The creel data were compared between 1994 and 1995. The cumulative length distributions of coho salmon were compared using a K-S test. A χ^2 test was used to

compare the ratios of males and females in the catch and harvest. The age distributions were compared using a χ^2 test. Mean length at age was compared using a t-test. All statistical comparisons were made using SYSTAT (Wilkinson 1990) at the $\alpha = 0.05$ level.

RESULTS

In 1994, we counted 205 angler days between 31 July to 11 September (Table 1). The peak effort occurred from mid August to early September. Approximately 20% of the effort was from unguided anglers. Of the 40 unguided angler days observed during the coho season, 23% considered themselves subsistence fishers.

In 1995, we counted 298 angler days between August 3 and September 24 (Table 2). Completed-trips interviews were obtained from 88% of the anglers. Of the completed-trip interviews, 207 (79%) were guided and 55 (21%) were unguided. Of the unguided fishermen, 29% considered themselves to be subsistence anglers.

In 1994, 489 coho salmon were caught by anglers in the outlet area and 66% were harvested (Table 1). Pink salmon comprised the next most abundant species caught during the fall fishery.

In 1995, the estimated catch of coho salmon by anglers in the outlet area was 694 of which 72% were harvested (Table 2). The catch per angler day ranged between 0 and 18 and only a small number of anglers practiced catch and release (Figure 3). Other species of fish were also caught, but their numbers were minimal and most were released (Table 3).

The length distributions of the coho salmon catch were found to be significantly different between the 1994 and 1995 sample years ($N = 512$, $D = 0.256$, $P < 0.001$; Figure 4). The modal age for 1994 and 1995 samples was 2.1 (Table 4). However, the age distributions of the 1994 and 1995 samples were found to be significantly different ($\chi^2 = 16.376$, $df = 4$, $P = 0.003$). The mean length at age of 1.1 coho salmon were not significantly different between 1994 and 1995 ($t = 1.98$, $df = 65$, $P = 0.052$) while age 2.1 coho salmon were significantly larger in 1994 than in 1995 ($t = 93.6$, $df = 342$, $P < 0.001$), and age 3.1 were significantly smaller in 1994 than in 1995 ($t = 2.35$, $df = 29$, $P = 0.026$).

The male to female ratio in the 1994 catch was 1.5♂:1♀ and did not differ significantly from the 1995 catch sex ratio of 1.3♂:1♀ ($\chi^2 = 0.685$, $df = 1$, $P = 0.408$). In 1994 and 1995, female coho salmon were significantly larger than males ($t = 4.89$, $df = 162$, $P < 0.001$; $t = 61.9$, $df = 364$, $P < 0.001$).

In 1995, the length distributions of the catch and harvest were not significantly different ($N = 705$, $D = 0.019$, $P = 1.000$). The sex ratios of caught and harvested coho salmon for 1995 were 1.3♂:1♀ and 1.2♂:1♀ respectively and were not significantly different ($\chi^2 = 0.142$, $df = 1$, $P = 0.707$).

Table 1.-Number of angler days, catch, and harvest of coho and pink salmon from the Egegik River, Becharof National Wildlife Refuge from 31 July to 13 September 1994.

	Angler days		Number of Fish			
			Coho		Pink	
Week	Guided	Unguided	Catch	Hrv	Catch	Hrv
July 31 - Aug 6	10	3	19	18	8	1
Aug 7 - Aug 13	6	18	30	7	16	2
Aug 14 - Aug 20	27	7	37	29	67	1
Aug 21 - Aug 27	46	0	171	104	62	2
Aug 28 - Sept 3	13	0	42	22	11	1
Sept 4 - Sept 10	37	12	116	97	49	0
Sept 11	26	0	74	48	30	0
TOTAL	165	40	489	325	243	7

Table 2.-Angler counts, complete-trip interviews and observed and estimated coho salmon catch and harvest by anglers at the outlet of Becharof Lake from August 3 - September 24, 1995.

Sampling Weeks	Observed				Estimated			
	Angler Counts	Complete-trip Interviews	Catch	Harvest	Catch	CI	Harvest	CI
Aug 3 - Aug 5	14	5	10	9	28	12.3	25	11.0
Aug 6 - Aug 12	45	45	83	65	83	0	65	0
Aug 13 - Aug 19	73	55	147	96	195	23.8	128	16.5
Aug 20 - Aug 26	40	40	122	64	122	0	64	0
Aug 27 - Sept 2	62	54	105	84	120	16.1	97	10.0
Sept 3 - Sept 9	43	43	83	71	83	0	71	0
Sept 10 - Sept 16	18	17	46	36	49	6.1	38	3.7
Sept 17 - Sept 23	1	1	0	0	0	-	0	-
Sept 24	2	2	14	14	14	0	14	0
TOTAL	298	262	610	439	694	31.9	502	22.5

Table 3.-Number and species of fish caught and harvested by anglers incidentally at the outlet of Becharof Lake from August 3 - September 24, 1995.

Species	Catch	Harvest
Pink Salmon	1	1
King Salmon	2	0
Chum Salmon	9	0
Arctic Grayling	1	1
Dolly Varden	27	3

Table 4.-Mean length at age and age composition of coho salmon caught by anglers in the Egegik River, Becharof National Wildlife Refuge, during 1994 and 1995.

Age	Mean	*N*	SD	Percent
		1994		
1.1	550.0	15	65.07	10.1
2.1	590.2	130	42.53	87.8
3.1	574.7	3	14.06	2.0
		1995		
1.1	546.5	52	42.88	17.3
2.0	360.4	5	15.20	1.7
2.1	563.6	214	49.90	71.3
3.0	341.0	1	-	0.3
3.1	584.3	28	37.28	9.3

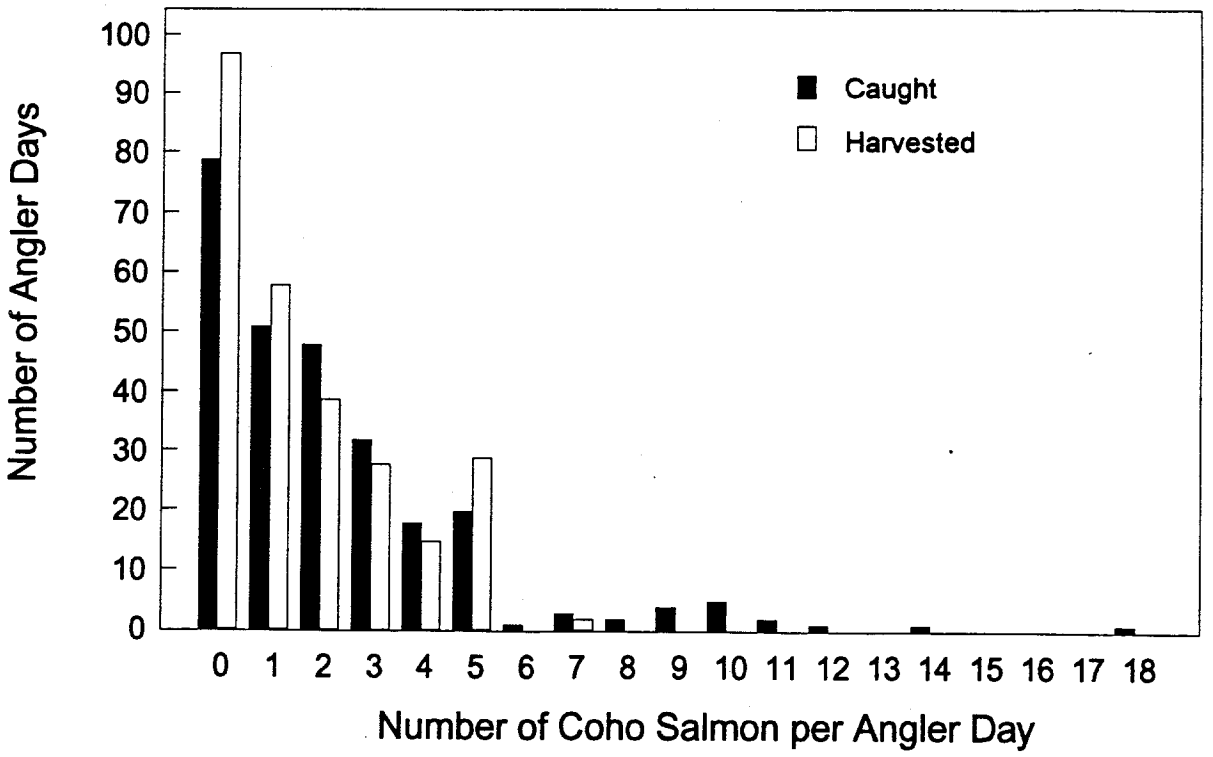

Figure 3.-Frequency of coho salmon caught and harvested per angler day in the Egegik River, Becharof National Wildlife Refuge, Alaska during 1995.

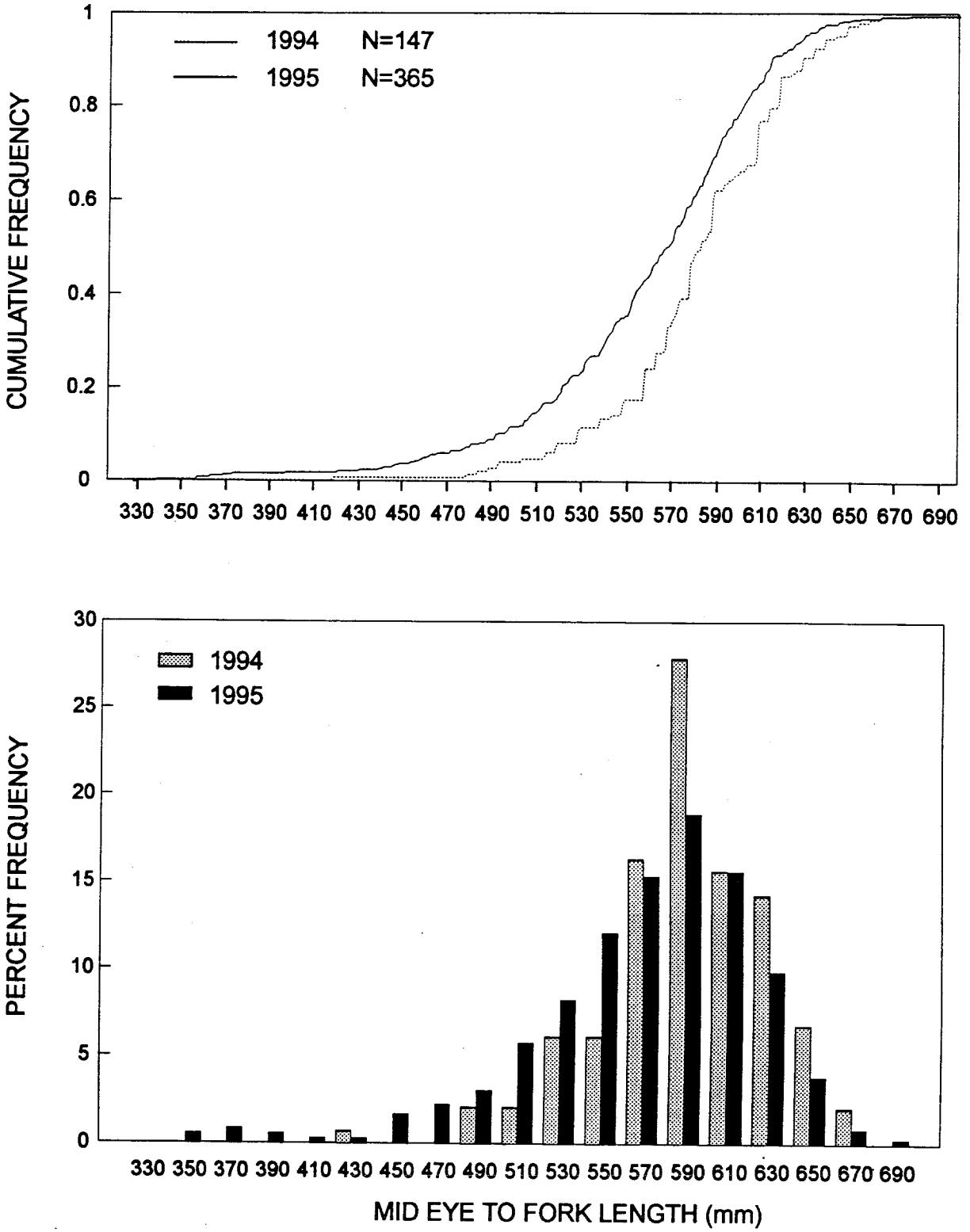

Figure 4.-Cumulative and percent frequency of the mid-eye to fork length for coho salmon caught by the sport fishery in the Egegik River, Alaska, 1994 and 1995.

DISCUSSION

Because of the small magnitude of the fishery and our ability to cover the sampling area several times a day, the angler counts were considered to be a survey of effort for the sampling period. Overall, we feel the estimates are accurate. Some variability may have been realized because of our assumption that all anglers fished the same amount each day. With 88% coverage of the angling effort, we feel the effects of variable fishing effort were minimized. Because fishing is likely to have occurred outside the survey area and before and after the survey period, catch and harvest estimates should be considered minimums for the Egegik River. However, from discussion with the guides and local anglers, we feel that the time frame and area of the creel survey account for the majority of catch and effort. The trend in angler counts further support that at least the timing of the creel survey was appropriate.

In 1994, we could not measure if our assumption of 100% coverage was valid. Intuitively, the assumption of 100% coverage was unlikely. However, the difference between 1994 and 1995 estimates was less than 200 fish. From a management viewpoint, the estimates were very similar and the conclusions drawn from the data would not be different. We would recommend that methodology similar to 1995 be utilized for future creel surveys in the area. If the fishery were to increase dramatically, then the methodology to estimate effort may need to be modified and the fishery estimated based on catch per hour versus catch per day.

We also compared the 1994 estimates with estimates from the Department's mail out survey (Mills 1995). The Department's estimates were 590 coho salmon caught and 426 harvested. Our estimates were about 100 coho salmon less. We would expect the Department's estimates to be larger because their estimates cover the entire season and drainage. Even though the mail out survey estimates the catch and harvest in the drainage the estimates reflect the catch and harvest in the Egegik River. From our aerial surveys and other public use camps, the coho salmon effort is currently focused in the Egegik River. Until the anglers start fishing other areas, the mail out survey will provide a good indication of sport harvest levels in the Egegik River. We could not compare the 1995 data at this time because the mail out survey data were unavailable.

One concern raised by the local residents was that sport angling had increased in recent years and that subsistence anglers were displaced. In general, angling effort has increased in Bristol Bay. To the extent increased angling effort has increased in the Egegik River is unknown. During the peak effort, about 10 anglers per day fished in the Becharof Lake outlet area. A majority of the effort was found to be from fishermen who considered themselves to be sport anglers. Although the area we surveyed could easily accommodate 10 anglers per day, the distribution of coho was limited and would concentrate the fishing effort to a few spots. Certainly, subsistence anglers used to having traditional fishing areas to themselves could feel displaced from the more popular fishing spots.

In comparison to the commercial fishery and escapement, anglers at the Becharof Lake outlet appear to have minimal effect on the coho salmon population. With sport harvests well under 1,000 coho salmon, the commercial fishery by far has a greater biological impact. The 1994 commercial fishery harvested about 48,000 coho salmon (Alaska Department of Fish and Game 1995). The subsistence gillnet fishery in the lower river was reported to have taken about 860 fish in that same year (Alaska Department of Fish and Game 1995).

The sport fishery harvested a high proportion of the coho salmon caught. Less than 20 anglers strictly practiced catch and release. Within the bag limit, anglers kept most of the fish they caught. Since most of the anglers fly out and return to the lodge on the same day, preservation and bear predation are not a major concern and permitted a consumptive fishery.

Length was not a factor in determining whether a fish was harvested. We observed that most fishermen harvested the fish until they met their limit. This practice would preclude much size selectivity. The fishery also did not selectively harvest one sex at a disproportionate rate. Although very few fish were released, the proportion of males and females in the catch was similar to the proportion of males and females in the harvest. The sex ratio of the population differed from a 1♂:1♀ but ratios as high as 2.07♂:1♀ have been observed in other populations of coho salmon (Groot and Margolis 1991).

The age composition was within the range reported from past commercial fishery samples in the Egegik District (Stratton 1990; and Stratton 1991). These data showed age 2.1 contributed between 69% and 87% of the total catch. The beach seine samples collected by the ADFG tower crew in 1995 showed age 2.1 comprised 65% of the sample (Russell 1996). The sport catch of age 2.1 in 1995 was 12% greater than the beach seine samples. The reasons for the difference are not known but may be related to sample timing or gear biases. We also observed considerable variability between years. Variability in age composition was also evident for the commercial fishery.

ACKNOWLEDGEMENTS

We wish to acknowledge and thank the Becharof Native Corporation and the residents of Egegik for supporting this survey. We are also grateful to the lodge operators, their guides, and their clients for participating in this survey. We thank the Student Conservation Association volunteers Tom Sutton and Kathleen Stovall, and Service volunteer Rob Baer for collecting the Data and the Alaska Department of Fish and Game for reading the 1994 scales.

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